J. Mar. Biol. Ass. U.K. (2001), **81**, 881–882
Printed in the United Kingdom

Dressing up for the deep: agglutinated protists adorn an irregular urchin

Lisa A. Levin*[‡], Andrew J. Gooday[†] and David W. James*

*Marine Life Research Group, Scripps Institution of Oceanography, La Jolla, California 92093-0218, USA. [†]Southampton Oceanography Centre, Empress Dock, Southampton, SO14 3ZH. [‡]E-mail: llevin@ucsd.edu

A specimen of the deep-water, spatangoid urchin, *Cystochinus loveni*, wearing a costume of agglutinated protists, was collected from 3088 m in the Gulf of Alaska, north-east Pacific. Over 24 putative taxa of living and dead foraminiferans and xenophyophores, as well as a sipunculan, polychaete, tanaid, and two isopods, were collected from the dorsal surface of this single individual. This is the first report of a deep-sea urchin using rhizopod protists and it is proposed that the urchin acquires camouflage or benefits from increased specific gravity associated with the protistan cloak.

A single specimen of *Cystochinus loveni* A. Agassiz, 1898 (~5 cm diameter), adorned with a collection of objects consisting mainly of living and dead agglutinated protist tests (Figure 1), was collected in a tube core taken with the submersible 'Alvin' at 3088 m along the Alaska continental margin, Gulf of Alaska (58°51.7′N 146°2.9′W). The urchin was collected from a plateau area along a steep cliff formed of block-like outcrops. Scientists viewing the urchin from the submersible during sampling believed it was either a xenophyophore or an anemone. The surrounding area was covered with silty sediments containing 5 cm high mounds, tubes and burrows. Asteroids and ophiuroids were visible on the sediment surface. Visual observations suggest that several urchins with similar covering were present in the same area, but no attempt was made to estimate densities.

The coat or costume on the urchin consisted of > 1000 protist (foraminiferan and xenophyophore) tests and test fragments, a sipunculan, a polychaete, a tanaid and two isopods, and four pebbles of basalt or clinker (Table 1). There were also sections of empty polychaete and pogonophoran tubes. The majority of the tests were tubular or plate-like agglutinated fragments. Most of the breakage of these fragile structures probably occurred after the urchin had been sampled, rather than being an original feature of the assemblage. Species present included a large flat reticulated xenophyophore that was initially intact, but subsequently broke into numerous pieces. The protists also included some remarkable *Rhabdammina*-like foraminiferan tubes (maximum length > 3 cm), studded with large quartz grains and each with four well-developed longitudinal ridges running along their inner surfaces. These tubes probably represent an undescribed genus and are identical to the *Rhabdammina*-like species reported from the Escanaba Trough, north-east Pacific, by Quinterno (1995).

Figure 1. The protist 'costume' adorning a single specimen of the spatangoid urchin, *Cystechinus loveni*, from 3088 m in the Gulf of Alaska. Most of the specimens are agglutinated Foraminifera, but xenophyophores were also recovered. A list of the protist specimens recovered is given in Table 1.

This unusually high concentration of discrete agglutinated structures, and the absence of loose sediment, suggests that either the urchin actively acquired the associated organisms and structures or that these organisms settled and grew on the dorsal portion of the urchin test. Passive accumulation of particles seems unlikely given the relative absence of loose sediment within the costume. The urchin seems to have selected objects in the mm–cm size range. In other respects, however, it probably did not discriminate and simply picked up objects of a suitable size which were lying about on the sediment surface. Most were agglutinated protists. The fact that some of the protists (e.g. xenophyophores) are large but very delicate, suggests that the urchin was able to manoeuvre them onto its back in a careful manner or possibly that the protists settled and grew there.

Cystechinus loveni (syn. *Urechinus loveni*) is widely distributed in the North Pacific, from off Mexico to the Bering and Okhotsk Seas at depths of 2600–4800 m Mortensen (1950). It is a surface-dwelling to semi-burrowing form (D. Pawson, personal communication). This is the first record of this species with a cover of living organisms.

Adornment behaviour or covering response is well known in a number of shallow-water tropical and subtropical urchins (Millott, 1956; Dix, 1970; Lees & Carter, 1972; James, 2000). Explanations for shallow-water covering behaviour have involved protection from desiccation or temperature extremes (Orton, 1929), concealment or camouflage from predators (see papers cited in Millott (1956); podial responses associated with food collection (Dix, 1970), light/ultraviolet light avoidance (Lees & Carter, 1972), and stabilization from surge transport (Lees & Carter, 1972; James, 2000). Of these, chemical camouflage or changes in specific gravity to reduce transport by currents seem the most probable explanations for covering behaviour in *C. loveni*.

We thank Sharon Franks, Zachary Held, and Dudley Foster for their participation in urchin collection during 'Alvin' Dive 3350, Dave Pawson for identification of the sea urchin, and D. Billett for providing access to relevant literature. Support for

Table 1. *Rhizopod protists found covering a single specimen of* Cystechinus loveni, *3088 m*.

Species	Maximum dimension of largest specimens	Live specimens	Dead specimens	Remarks
Astrorhizacea				
Bathysiphon flavidus	15.5 mm	0	3	All fragments
Rhabdammina parabyssorum	9.5 mm	0	17	All fragments
R. aff. *discreta*	24.5 mm	21	27	Most specimens appear to be fragments; none exhibit prolocular swelling
R. neglecta	15.5 mm	17	33	Similar to tubes illustrated by Gooday (1986) but none exhibit prolocular swelling
Rhabdammina-like tubes	33 mm	1	9	Studded with large quartz grains; identical to the *Rhabdammina*-like tubes of Quinterno (1995); all except longest probably fragments
Rhizammina narrow form	8.5 mm	> 500 larger (> 3 mm) fragments		Tube diameter 140–160 μm at least some fragments are live
Rhizammina wider form	7 mm	~ 180 larger (> 3 mm) fragments		Tube diameter 240–360 μm
Narrow, soft-walled tubes (diameter ~80 μm) with short side branches	5 mm	8	0	Most are probably live
Long narrow, flexible tube (diameter 60–180 μm) with organic wall, filled with light-coloured 'sediment'	9 mm	21 ?live		Difficult to determine whether these tubes are live or dead or whether they are Foraminifera
Hyperamminacea				
Hyperammina friabilis	16 mm	1	11	Five fragments with proloculus, seven without
Tolypammina sp.	3.5 mm	2	0	Fragments
Crithionina sp.	< 1 mm	10		Attached to agglutinated tube
Astrorhizacean mudballs	< 1 mm	3	0	
Multi-chambered agglutinated				
Hormosina monile		4	1	
Reophax mortenseni	15 mm	2	2	Longest specimen complete, others fragments
Cribrostomoides subglobosa	< 1 mm	2	3	Two attached to agglutinated tubes
Clusters of dome-like pustules		8	0	
Komokiacea				
White *Lana*		0	1	Probably dead
Edgertonia-like mudballs		7		Probably live
Chain-like form		1	0	Probably live
Calcareous				
Cibicides sp.	800 mm	4	0	
Xenophyophores				
Psammina sp.	5 mm	80	0	Flat fragments with broken edges revealing internal 'pillars' characteristic of genus; wall with coarse-grained inner layer, finer-grained outer layer
?*Psammina* sp.	3 mm	79		Flat fragments which incorporate open spaces; largest piece encloses three spaces; most one space or partial space (i.e. the circuit is incomplete). Wall structure similar to *Psammina* sp.
?*Galatheammina* sp.	6 mm	86	0	Fragments cylindrical or plate-like in form; test solid with longitudinally-running stercomare and granellare strands

the research was provided by the NOAA West Coast National Undersea Research Center (98-0038).

REFERENCES

Dix, T.G., 1970. Covering response of the echinoid *Evechinus chloroticus* (Val). *Pacific Science*, **24**, 187–194.

Gooday, J., 1986. The genus *Rhabdammina* in the northeast Atlantic; a new species, a redescription of *R. major* de Folin, 1987, and some speculations on species relationships. *Journal of Foraminiferal Research*, **16**, 150–160.

James, D.W., 2000. Diet, movement, and covering behavior of the sea urchin *Toxopneustes roseus* in rhodolith beds in the Gulf of California, Mexico. *Marine Biology*, **137**, 913–923.

Lees, D.C. & Carter, G.A., 1972. The covering response to surge, sunlight, and ultraviolet light in *Lytechinus anamesus* (Echinoidea). *Ecology*, **53**, 1127–1133.

Millott, N., 1956. The covering reaction of sea urchins. I. A preliminary account of covering in the tropical echinoid *Lytechinus variegatus* (Lamarck), and its relation to light. *Journal of Experimental Biology*, **33**, 508–523.

Mortensen, T.H., 1950. *A monograph of the echinoidea*, vol. 1. *Spatangoida I.* Copenhagen: C.A. Reitzel Publisher.

Orton, J.H., 1929. On the occurrence of *Echinus esculentus* on the foreshore in the British Isles. *Journal of the Marine Biological Association of the United Kingdom*, **16**, 289–296.

Quinterno, P., 1995. Quaternary foraminifers from the Escanaba Trough, northeast Pacific Ocean. In *Geologic, hydrothermal, and biological studies at Escanaba Trough, Gorda Ridge, offshore Northern California* (ed. J.L. Morton et al.). *US Geological Survey Bulletin*, **2022**, 337–359.

Submitted 2 August 2000. Accepted 17 July 2001.